Risk Assessment

Fact Sheet

What is Risk Assessment?

Risk assessments are a tool established by EPA to evaluate human exposure to chemicals, pesticides, hazardous wastes, air pollution, drinking water contaminants, and surface water pollutants at a site. Project teams conduct risk assessments to protect human health and the environment, to establish environmental cleanup goals, and to prioritize cleanup efforts.

Risk is the chance that chemicals from a site could cause adverse health effects.

Risk assessments answer four basic questions:

- Is there a risk?
- What is causing the risk?
- Who is at risk?
- How great is the risk?

Risk assessors use the best available site data and their scientific judgment to calculate the likelihood of exposure to contaminants at a site. They then characterize threats posed by contaminants in groundwater, surface water, air, soil, and the food chain. Risk assessment is not an exact science.

Community Input: People who live near the site can help the project team by answering questions about who may be exposed to contaminants, how they may be exposed, and where they may be exposed.

What Does a Risk Assessment Involve?

A risk assessment has four phases: hazard identification; exposure assessment; toxicity assessment, and risk characterization (see Figure 1).

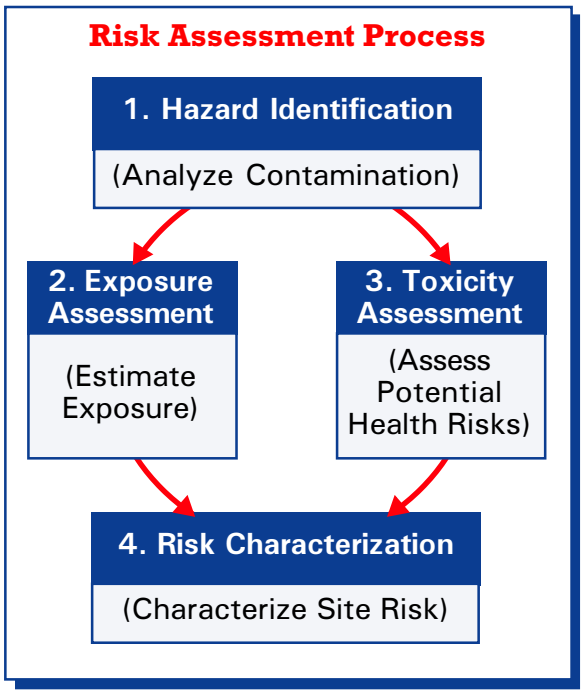

Figure 1

1. Hazard Identification

During ***Hazard Identification***, risk assessors collect data and evaluate contamination at the site. They begin by forming a work plan for the risk assessment to identify:

- Past site uses, disposal practices, spills, or other activities around the site
- Gaps in existing data
- Sampling locations and requirements
- Community health concerns
- Current and future anticipated land uses at the site (e.g. agricultural, residential, recreational, and industrial)

Risk assessors may collect and review samples from soil, air, surface water, groundwater, sediment, plants, and fish and animals at and around the site. They focus on chemicals that may cause an adverse health

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effect. These chemicals are referred to as the *chemicals of concern*. Risk assessors then evaluate potential concentration levels for each chemical of concern in each medium (such as soil, groundwater, air) and use computer models to help predict movement in relation to nearby communities.

Community Input: This is a good time to educate the community about the risk assessment process. Community members can provide critical information about current and future land uses, historical disposal practices, areas of concern at or near the site, health concerns, and how people may be exposed (e.g. fishing, gardening, playing).

2. Exposure Assessment

An exposure assessment determines how people are exposed to chemicals of concern, who could be exposed, and how much of the chemicals people are exposed to. Exposure assessments consider both present exposures and probable future exposures, based on anticipated land uses.

If there is no exposure, then there is no risk.

The exposure assessment is conducted in three steps:

Step 1. Characterizing the exposure setting—The setting includes the climate, vegetation, groundwater hydrogeology, and the location of any surface water bodies at or near the site. This step also includes describing the potentially exposed population—especially sensitive groups such as children, the elderly, pregnant and nursing women, and people with chronic illnesses—and their activity patterns. It also includes current and anticipated land uses.

Step 2. Identifying exposure pathways—An exposure pathway is the course a contaminant takes from the source to an individual (see Figure 2). The following are some examples of exposure pathways:

- Ingestion of groundwater from local wells down-gradient of the site (residents)
- Inhalation of chemicals volatilized from groundwater during home use (residents)
- Ingestion of chemicals that have accumulated in fish from ponds on the site (residents)
- Direct contact with chemicals of concern in soil on the site (workers)

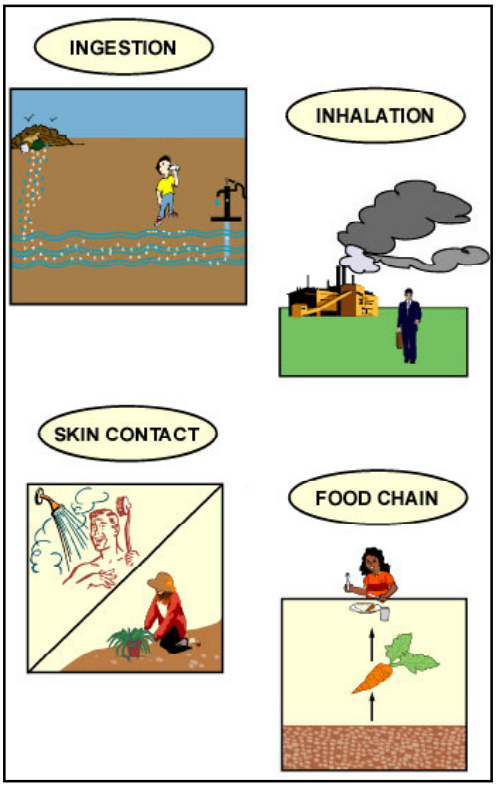

Figure 2

Step 3. Quantifying exposure—Based on steps 1 and 2, the risk assessors determine which exposure pathways to quantify in terms of the magnitude, duration, and frequency of exposure. They estimate intake dose for each pathway. Intake dose estimates are based on five factors:

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- Concentration of a chemical at an exposure point, such as a drinking water well
- Contact rate, or the amount that a person takes in over a specified time
- Exposure frequency and duration, or how often and for how long people could be exposed
- Body weight for each age group
- Exposure averaging time in days. For a chemical that may cause cancer, the risk assessor averages the total exposure over a lifetime to determine a lifetime average daily dose. For a chemical that has non-cancer effects, the exposure is averaged over 365 days.

Risk assessors use the intake dose to determine a reasonable maximum exposure (RME) for each pathway. The RME is the highest dose anyone is likely to receive from the site. The RME estimates are conservative. They are intended to protect even the most vulnerable groups. RMEs are calculated for various groups, such as site workers, residents, and sensitive populations.

Exposure assessments highlight the assumptions used and any uncertainties associated with the assumptions. When site exposure information is lacking, risk assessors use EPA's standard assumptions or default factors. Community input is sometimes used to modify the assumptions.

Community Input: Since the exposure assessment includes information about activities of people who work and live near the site, community input is critical during this stage to ensure that the risk assessment is realistic, credible, and comprehensive. Sample questions for community input include:

- Who comes into contact with the site?
- How do people use the land on and near the site (e.g., fishing, gardening, berry picking, hunting, playing, swimming)?
- How often do people use the land for these activities?
- Where do these activities take place?
- What types of animals are hunted or fished?
- What types of food are produced in gardens nearby?

3. Toxicity Assessment

The toxicity assessment determines potential health effects of the chemicals and the level of exposure that causes adverse effects.

Risk assessors refer to published research to determine health effects of particular chemicals. Information comes from research performed by universities, industry, the government, and others. Toxicity data is available on EPA's Integrated Risk Information System (IRIS). It is derived from animal studies, epidemiology studies, and occasionally from studies of people in the workplace.

Epidemiology - the study of widely prevalent epidemic diseases in an area.

Another important factor considered is the frequency and length of exposure. *Acute exposure* refers to short-term exposure from a large single event or a limited number of exposures within a short time, generally less than 24 hours. Acute exposure to certain chemicals may cause such effects as breathing difficulties, vomiting, rashes, and even death. Occasionally, acute exposure can cause a delayed health effect. *Chronic exposure* refers to repeated exposure over a long time—usually years. Chronic exposure can cause damage months or years after exposure began.

Risk assessors evaluate dose-response relationships and develop toxicity values for each chemical to determine whether it has cancer or non-cancer

effects. Cancer and non-cancer effects are analyzed differently.

Cancer effects—Risk assessors express cancer risk as an individual probability or chance of getting cancer. For cancer-causing agents, risk assessors assume that even very low doses may cause cancer in a small percentage of the exposed population. The toxicity value for cancer-causing agents is referred to as the *slope factor*. It defines the relationship between the dose amount and the effect.

Non-cancer effects—Some substances require a certain amount of exposure, called a *threshold dose*, before adverse health effects will occur. EPA has established risk levels that are referred to as *safe dose* or *reference dose* (RfD) amounts.

4. Risk Characterization

Risk characterization summarizes the risk assessment results. The goal of the risk characterization is a clear and understandable discussion of the site risks. Risks for individual chemicals are added across exposure pathways to present a total risk.

Cancer risks are presented as individual probabilities (above normal levels). The numbers are expressed in scientific notation. For example, 3×10^{-2} means 3 chances in 100. EPA has established a safe risk range between 10^{-4} and 10^{-6}. A risk of 10^{-4} represents a lifetime probability of one extra cancer case in a population of 10,000. A risk of 10^{-6} is the probability of one extra cancer case in a population of 1,000,000.

Non-cancer risks are described as a number, referred to as the *hazard quotient* (HQ). An HQ less than 1 means the chemical is not likely to cause harm. An HQ higher than 1 means there is potential for harm. The higher the HQ, the greater the potential for harm.

An important part of risk characterization is defining the *uncertainty* associated with the assessment. Uncertainty exists because scientists lack sufficient information on actual chemical exposure and how chemicals may harm people. Uncertainty is due to:

- Inadequate sampling
- Incomplete information about how people might come into contact with site chemicals
- Lack of information on how a chemical can harm people
- The use of experimental animal studies to estimate human risks

Because these uncertainties cannot be eliminated, safety factors are built into the risk assessment process that tend to overestimate the actual risks.

Community Input: The goal of community input during the risk characterization is to ensure that risks are described in a clear and meaningful way, and that site-related assumptions are still appropriate. It is important to determine if community concerns have been adequately addressed; if any contaminants, exposure pathways, or sensitive groups have been overlooked; if the risk assessment process and conclusions are understandable; and if the community understands how the risk assessment is being used.

About RSRE

The Health Risk Assessment Branch (RSRE) of AFIERA is the Air Force resource for environmental risk evaluation and communication. The branch provides a broad range of risk assessment, toxicology, and risk communication support to Air Force installations. For more information, contact Cornell Long at Phone: 210-536-6121.